

IN 1200M
71-70-CR
1407

NASA / Long Term Space Astrophysics program

Project Title: THE PROPERTIES OF INTERSTELLAR DUST GRAINS 032 380
IN CIRRUS CLOUDS

A lot of progress was made on all aspects of the project during the second year of the project, 1 May 1996 to 30 April 1997.

Following a successful search for a postdoctoral fellow in the Spring of 1996, Dr. Arpad Szomoru (PhD, 1994, University of Groningen) was hired out of an excellent pool of 30 applicants. While at the University of Groningen, The Netherlands in the summer of 1996, Dr. Szomoru started some of the initial reduction of wide field *UBVRI* CCD images of cirrus clouds obtained with the CTIO and KPNO Schmidt telescopes. He joined UCO/Lick Observatory on the University of California's Santa Cruz campus in August last year and started work full time on this cirrus project.

The main emphasis of this year's research was analysis of existing wide field, optical (*UBVRI*) CCD images of cirrus clouds obtained using the KPNO and CTIO Schmidt telescopes in October 1995 and February 1996. Dr. Szomoru and I have been working in close collaboration for the past several months trying to derive optical surface photometry of the cirrus. We have developed and tested several techniques to effect careful PSF fitting and subtraction of Galactic field stars in these images. The data analysis software we have developed is a combination of several IRAF and DAOPHOT modules. An important by product of star removal is a list of *UBVRI* magnitudes of field stars, some in front of the cirrus cloud, but most in the background. By studying the offset of each star from fiducial stellar loci in the $U - B$ vs $B - V$, $B - V$ vs $V - R$, and $V - R$ vs $R - I$ color-color diagrams, we are able to estimate the reddening and optical depth associated with the cirrus. This in turn provides a statistical measure of the distance to the cirrus cloud (based on estimates of the spectroscopic parallax to the unreddened and reddened field stars along the line of sight to the cirrus) as well as constraints on the temperature of the dust grains (when combined with IRAS and ISO far infrared surface brightness measurements).

In collaboration with researchers at NASA's Infrared Processing and Analysis Center in Pasadena, CA and at the Institut d'Astrophysique Spatiale in Orsay, France, I have been engaged in using the IRAS database to select a representative subsample of cirrus clouds spanning a wide range of Galactic latitude and longitude. These clouds have been targeted for optical *UBVRI* studies. Recently, some of these cirrus clouds have also been observed as part of an ISO Key Program, and I am working closely with members of that team.

There are three new directions that this project has taken during the past year. A

proposal to obtain snapshot exposures in F606W (broad V band) and F814W (I band) of cirrus cloud edges with NASA's Hubble Space Telescope in Cycle 7 was successful. Observations will start later this year. These high resolution images will be used to study the fine structure of cirrus. This is important for understanding the nature of physical processes that shape the cirrus and has interesting implications for deep imaging and photometry of extragalactic objects. Secondly, we obtained deep $H\alpha$ images of a subset of our cirrus cloud sample (for which we already have $UBVRI$ photometry) during a CTIO Schmidt run in October 1996. These data should serve as a useful probe of the warm ionized gas content of cirrus clouds. Finally, a program has been initiated to obtain low dispersion spectra of cirrus cloud edges using with the Lick 3-meter telescope + KAST spectrograph. A pilot observing run was carried out by Dr. Szomoru and myself in mid April 1997, and the results look promising. The main goal of this program is to test whether the unusually red $R - I$ and $B - R$ colors of the cirrus are caused by photoluminescence in hydrocarbon molecules.

Several observing trips were undertaken during this the second year of the LTSA project. These include observing runs on the CTIO Schmidt telescope (Chile), the Keck telescope (Hawaii), and the Lick Shane telescope (Mt. Hamilton, California). I also attended conferences in Pusan and Sorak (Korea).

Publications since 1 May 1996 (including papers in press)

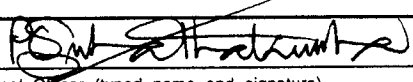

1. P. D. Edmonds, R. L. Gilliland, P. Guhathakurta, L. D. Petro, A. Saha, and M. M. Shara 1996, *ApJ*, **468**, 241.
2. P. Guhathakurta, B. Yanny, D. P. Schneider, and J. N. Bahcall 1996, in *Dynamical Evolution of Star Clusters*, ed. J. Makino and P. Hut (Kluwer, Dordrecht), p19.
3. P. Guhathakurta, B. Yanny, J. N. Bahcall, and D. P. Schneider 1996, in *Dynamical Evolution of Star Clusters*, ed. J. Makino and P. Hut (Kluwer, Dordrecht), p??.
4. G. Bernstein, P. Guhathakurta, and S. Raychaudhury 1996, in *Spiral Galaxies in the Near Infrared*, ed. D. Minniti and H.-W. Rix (Springer/Verlag), p200.
5. D. Reitzel, P. Guhathakurta, and A. Gould 1996, in *Formation of the Halo...Inside and Out*, ed. H. Morrison and A. Sarajedini (ASP Conference Series, vol. 92), p540.
6. H.-W. Rix, M. M. Colless, and P. Guhathakurta 1996, in *New Light on Galaxy Evolution*, ed. R. Bender and R. Davies (Kluwer, Dordrecht), p241.
7. P. Guhathakurta, K. Ing, H.-W. Rix, M. M. Colless, and T. B. Williams 1996, in *New Light on Galaxy Evolution*, ed. R. Bender and R. Davies (Kluwer, Dordrecht), p385.
8. D. Reitzel, P. Guhathakurta, and A. Gould 1996, in *New Light on Galaxy Evolution*, ed. R. Bender and R. Davies (Kluwer, Dordrecht), p437.

9. P. Guhathakurta, K. Ing, H.-W. Rix, M. M. Colless, and T. Williams 1996, *JKAS*, **29**, S63.
10. P. Guhathakurta 1996, *JKAS*, **29**, S139.
11. R. L. Cohen, P. Guhathakurta, B. Yanny, D. P. Schneider, and J. N. Bahcall 1997, *AJ*, **113**, 669.
12. H.-W. Rix, P. Guhathakurta, M. M. Colless, and K. Ing 1997, *MNRAS*, **285**, 779.
13. S. Raychaudhury, K. von Braun, G. M. Bernstein, and P. Guhathakurta 1997, *AJ*, in press (June issue).
14. J. A. Tyson, P. Fischer, P. McIlroy, R. Wenk, P. Guhathakurta, J. Huchra, L. Neuschaefer, K. Ratnatunga, V. Sarajedini, and K. Glazebrook 1997, *ApJ*, in press.

NASA PROPOSAL BUDGET FORM - LONG-TERM SPACE ASTROPHYSICS PROGRAM

Period: 5/1/97-4/30/98

NRA 96-OSS-13

Co-Principal Investigator Puragra Guhathakurta		Institution The Regents of the University of California		Proposal Title The Properties of Interstellar Dust Grains in 'Cirrus' Clouds				
A. Salaries, Senior Personnel		Monthly or Hourly Rate	No. of Months	Funds Grant Year 1	Funds Grant Year 2	Funds Grant Year 3	Funds Grant Year 4	Funds Grant Year 5
1. PI Puragra Guhathakurta						\$		
2. Co-I								
3. Co-I								
4. Co-I								
B. Salaries or Wages, Other Personnel (show numbers in parentheses)								
1. (1) Post Doctoral Associates			12 mos/yr			\$ 33,664		
2. () Other Professionals (Technicians, Programmers, etc.)								
3. () Clerical								
4. () Other (specify)								
C. Fringe Benefits (if charged as direct costs; specify)						\$ 7,271		
Total Salaries, Wages, and Fringe Benefits (A+B+C)						\$ 40,935		
D. Permanent Equipment, incl. Workstation (list each item > \$5000; continue on separate sheet if necessary)								
Total Permanent Equipment						\$		
E. Travel, Domestic (incl. Canada, U.S. Possessions)						\$ 6,420		
Travel, Foreign						\$ 2,275		
F. Other Direct Cost						\$ 200		
1. Materials and Supplies								
2. Publication Costs (rate/page x no. of pages)						\$ 3,000		
3. Computer Services (rate/hr)						\$ 2,226		
4. Subgrants/Contracts (specify)								
5. Other (specify) Long distance telephone: \$200 Postage: \$200 Duplicating : \$100						\$ 500		
G Total Direct Cost (A through F)						\$ 55,556		
H Indirect Costs (specify)								
On campus research rate of 48.5% of total direct costs						\$ 26,944		
I. Total (G+H)						\$ 82,500		
PI (signature) 								
Cognizant Institutional Officer (typed name and signature) Marilyn J. Homer 		Position/Title Senior Research Administrator, Sponsored Projects Office						
		Address and Tel. No. of Institution's Sponsored Research Office 1156 High Street Santa Cruz, CA 95064 408-459-2639						

If more space is needed, please continue on back of this form or use separate sheet.

DETAILED BUDGET:**5/1/97-4/30/98****BUDGET CATEGORY****AMOUNT****A. SENIOR PERSONNEL**

Principal Investigator

Puragra Guhathakurta

0

Total Senior Personnel

0

B. OTHER PERSONNEL

Postdoctoral Reseacher

Dr. Arpad Szomoru

100.00% time 12.00 cal mos

33,664

Total Other Personnel

33,664

TOTAL SALARIES AND WAGES

33,664

C. FRINGE BENEFITS

Postdoctoral Reseacher

21.60%

7,271

Dr. Arpad Szomoru

TOTAL FRINGE BENEFITS

7,271

TOTAL SALARIES, WAGES, AND FRINGE BENEFITS

40,935

D. PERMANENT EQUIPMENT

0

E. TRAVEL**Domestic**

1. 2 rt ea yr for PI or Postdoc to

East Coast to attend scientific conference

(Rates based on Washington,DC)

Air Fare: 481

Per Diem/day: 166

Days: (4) 664

Grd Trans (SF): 71

2,432

2. 3 rt, S.C., CA-Pasadena,CA for PI

for archival data retrieval and

analysis at NASA's IPAC

Air Fare: 128

Per Diem/day: 149

Days: (5) 745

Grd Trans: 71

2,832

3. 2 rt, S.C., CA-Tucson, AZ for PI

or Postdoc for observation at Kitt

Peak National Observatory

Air Fare: 122

Per Diem/day: 55

Days: (7) 385

Grd Trans: 71

1,156

Total Domestic Travel	6,420
-----------------------	-------

Foreign

1. 1 rt ea yr for PI or Postdoc to Europe
to attend international conference
(Rates based on Cambridge, England)

Air Fare:	1000	
Per Diem/day:	172	
Days:	(7)	1204
Grd Trans:	71	2,275

Total Foreign Travel	2,275
----------------------	-------

TOTAL TRAVEL	8,695
--------------	-------

F. PARTICIPANT SUPPORT COSTS	0
-------------------------------------	---

G. OTHER DIRECT COSTS

1. Materials and Supplies
- | | |
|---|-----|
| a. Computer supplies, paper cards, etc. | 200 |
|---|-----|

Total Materials and Supplies	200
------------------------------	-----

2. Publication Costs/Page Charges 3,000

3. Computer (ADPE) Services 0

a. User Fees:	12 mos @ 65/mo	780
---------------	----------------	-----

b. Connect Fees:	12 mos @ 67/mo	804
------------------	----------------	-----

c. Maintenance contract- partial cost	642
---------------------------------------	-----

Total Computer Services	2,226
-------------------------	-------

4. Subcontracts 0

5. Other

a. Long-distance telephone	200
----------------------------	-----

b. Duplicating	100
----------------	-----

c. Postage	200
------------	-----

Total Other	500
-------------	-----

TOTAL OTHER DIRECT COSTS	5,926
--------------------------	-------

H. TOTAL DIRECT COSTS	55,556
------------------------------	--------

I. INDIRECT COSTS

Indirect Cost Base	55,556
--------------------	--------

On campus research rate of 48.5% of MTDC	26,944
--	--------

TOTAL INDIRECT COSTS	26,944
----------------------	--------

J. TOTAL DIRECT AND INDIRECT COSTS	82,500
---	--------